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THE TEACHING OF MATHEMATICS IN THE COLLEGES.

By H. E. SLAUGHT, The University of Chicago.

The first decade of the twentieth century is witnessing a wide spread wave of interest in the better teaching of secondary mathematics. This interest includes both the subject-matter and the form of presentation and arrangement in the curriculum and also the preparation of teachers for secondary schools.

Among the important activities pertaining to the subject-matter and its presentation may be mentioned the large number of associations of teachers, banded together for the purpose of improving the teaching of mathematics, in cities, in states, and in large sections of the country, such as the New England Association, the Middle States and Maryland Association, and the Central Association. In all of these associations, by papers, discussions, syllabi, committee reports, and experience meetings, every phase of secondary mathematical work has undergone the most careful reconsideration.

With respect to the preparation of teachers of secondary subjects, a great change has also taken place in recent years. Whereas, formerly there was no prevalent demand for college graduates as high school teachers, it is now true that it is very difficult for a teacher without a college degree to secure an appointment in any first-class high school. But further than this, specific training in the principles and practice of education is coming to be demanded. A notable instance of this is the state requirement in California, where no teacher can be certificated without a year's work in education in the University of California or in some institution where work of a high grade is offered.

While doubtless this standard of preparation has been set by the better equipped universities and by the few schools or colleges of education, yet the demand for such training is now being reflected back from the schools and compelling colleges and universities all over the country to turn their attention to the departments of education. The writer, in connection with the Board of Recommendations of the University of Chicago, had occasion recently to ask information from about two hundred institutions with respect to the training and appointment of teachers. The replies indicated that about fifty colleges and universities either already have, or are about to establish, schools or colleges or departments of education, or are taking steps to strengthen this work where it already exists. It would seem, therefore, with normal schools and certain schools of education devoting themselves to the training of teachers for the elementary schools, and with the colleges and universities awakening to their responsibility for the better preparation of teachers for the secondary schools, that education below the college grade is in a fair way to receive due attention, and with respect to mathematics that it will come in for its share of attention both as to subject-matter and as to the preparation of teachers.

But what of the teaching of college mathematics and the preparation of teachers for work in colleges? Where are the associations devoted to the improvement of teaching mathematics to Freshmen and Sophomores? What universities are offering courses in education especially intended for the preparation of teachers for colleges? Is it to be inferred that special training is regarded as necessary for a secondary teacher of mathematics, but that any one who knows the subject can teach a Freshman? An instructive address* bearing upon this subject was delivered before the Association of Doctors of Philosophy of the University of Chicago last June by Professor Charles Hubbard Judd, the new director of the School of Education at Chicago. The Association had been considering for two years the Relation of the Doctorate to the Teaching Profession, and a symposium† including the opinions of many of the Doctors, together with many important addresses on the subject, have been printed and distributed. Professor Judd's topic was: "The Department of Education in American Universities," and the following scattered sentences will indicate its bearing:

> I have been invited to discuss further the subject which you had under consideration last year, namely, the problem of turning Doctors of Philosophy into efficient teachers. There are some of you, I see by the printed reports of your earlier meeting, who regard the ability to teach as a natural gift. There are apparently many of you who are persuaded that courses in pedagogy cannot contribute materially to the improvement of a graduate of a university. In the face of such settled views, backed up by the success that many of you have obtained in the teaching profession, it seems to be a bold and from some points of view a useless undertaking to come before you as I must with the assertion that ability to teach is not a natural gift and that every Doctor of Philosophy would be improved by a careful consideration in a scientific and historical way of the problems of education. * * * * * * *
>
> Until very recently university and college organizations have been based on the opinion expressed by some of you that teaching cannot be made a subject of special study and instruction. Gradually, however, a change is being worked out before our eyes. In spite of opposition and indifference, courses in education are being organized even in the most conservative institutions. * * * * *
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> The first fact which I wish to point out is that there is a great deal of poor teaching

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*Printed in the November, 1909, *School Review*. A few reprints may still be had.

†This has been reprinted and a few copies may still be had by applying to the Secretary of the Association at the University of Chicago.

> within our universities and colleges, and this fact can be traced to a neglect upon the part of academic men and women of the form in which they arrange their material. *
>
> It is widely recognized that such a neglect of form as I have indicated appears in much of our university lecturing. The assumption of the ordinary university lecturer is that if he presents a certain body of material so organized that it seems to him to be fairly coherent and logical in its character, it is a matter of small moment whether it appeals to the students because of its literary form or whether it is easily intelligible to them because of its careful adjustment to their present stage of developement. * *
>
> The elective system has in part overcome this attitude and there is a very much more general conviction on the part of college instructors now than there was a generation ago that the demands of the student that the material shall be presented in clear and coherent form should be met. An instructor who is in competition with the other members of his own department for students in his course is likely to recognize the importance of preparing his material as clearly as possible for presentation to his class. * *
>
> It is obvious that everyone who is successful in the art of teaching must have complied with the demands indicated in the foregoing discussion; that is, he must have organized his material in such a way that it has significance not only for his own mind but also for the minds of others. The teacher who does not sympathize with his pupils fails commonly because he does not recognize the type of fact which we have just been discussing.

It should not be inferred from the opening sentence above quoted that all of the five hundred Doctors of the University of Chicago look with distrust upon the proposition that a university man who expects to teach in a college or university should know something of the principles, history and practice of education in general and much of these things as they pertain to his own department in particular, in order that he may, at least, avoid the historic blunders of his predecessors. The following quotation from the symposium bears upon this point:

> As matters now stand, whatever the *ideal* held by the university world in regard to the high calling of the doctor in the field of pure research, the *fact* is that the great majority of the doctors now turned out in this country are nominated and pushed by their respective departments, for teaching positions, which they must fill successfully or be counted as failures by all who measure the ratio of results accomplished to tasks undertaken.
>
> *Success in teaching* is well-nigh *indispensable* (save perhaps in a great university, where failure is less conspicuous because of the large numbers and multifarious interests). If the doctor is to gain encouragement and opportunity to go on with his research, he must first establish a reputation for himself in the community where he goes, for soundness of judgment, clearness of presentation, and power to inspire and lead students; then, having made sure of his ground, he can have pretty much his own way in planning and carrying out his work in the interest of his research. But, on the contrary, if in his blind devotion to his ideal he fails at the outset to teach successfully, to inspire and to lead students, he thereby cuts himself off from his very best resources for ultimately accomplishing his highest aims.
>
> These being the facts as realized in everyday experiences, the conclusion is forced upon us that the universities must prepare for teaching those doctors whom it is proposed to recommend as teachers, and preparations must include breadth of culture, eliminations of angularities, development of pedagogical sense, and some acquaintance with the great educational movements of the past and present. If it be urged that these, some or all of them, are either matters of personal quality or are foreign to the great purpose of the graduate school as director of explorations in unknown fields, then the other conclusion is forced upon us that only those doctors should be recommended as teachers who possess by

> nature the prerequisities or have developed them *outside* or *in spite of* the graduate school, and that the present indiscriminate practice of recommending any doctor as a teacher, however narrow or however lacking in the elements of pedagogic sense and power to teach, be superseded by a careful discrimination and selection of those who are prepared to teach and a refusal to nominate or recommend those who are not.
>
> Such a discrimination will lead, as it should, to a more careful and personal consideration of every individual's candidacy for the doctorate, and will compel a readjustment of curriculum and a recognition as a distinct field of that broad, thorough, and scientific training, commensurate with any standard now set up for the doctorate, which is demanded by the man or woman as a preparation for the highest attainment in teaching, leaving undisturbed the narrowest and possibly the deepest channels of pure research to be followed by those who either have not the time or have not the inclination, or perchance have not the personal qualities needed in preparation for teaching.
>
> This leads again and finally to the conclusion either that the number of those who are encouraged to go on to the doctorate should be greatly diminished, or else that the basis of the doctorate should be greatly broadened so as to provide the highest standards and the strongest preparation for the noble art of teaching, as well as to produce fine investigators.

Whatever may have been the attitude of the universities up to this time in regard to training men as teachers for college positions, it is clear that from this time forward the demand is likely to increase for men thus trained, not only because the colleges themselves are awakening to the necessity of better teaching, but also because the irresistible wave of progress in this respect in the secondary schools is bound to reach up into the colleges and shame them into action. Fortunately, however, the agitation is already begun to some extent with respect to the colleges, under the challenge of such men as Abraham Flexner and with the support of many who are loyal to the cause of better teaching.

But while the question of better training for teachers of mathematics is sure to get consideration along with the like questions for all other departments in the general upward movement, it is the special responsibility of the mathematicians themselves to consider the subject-matter of the collegiate curriculum, with respect to its better arrangement, better form of presentation, closer contact with concrete applications, closer correlation with related departments, such as Physics, Astronomy, Chemistry, Geology, and better adjustment to both the earlier and later work in the department. In this connection also belongs the consideration of all these questions concerning mathematics as related to students in the literary courses, in the general science courses, in the specialized science courses, in the small college and in the great university.

It is well known that changes have been going on in respect to the status of various branches of mathematics in the college curriculum; for instance, as to the content of College Algebra, the scope of Trigonometry and of Analytic Geometry, the proper adjustment of theory and applications in the Calculus, and the whole question as to whether all of these branches should not be considered as one subject—Mathematics—rather than as separate topics carefully partitioned off from each other both theoretically and pedagogically.

The editors of the MONTHLY have decided to open its columns to contributions on the teaching of collegiate mathematics, in the hope that some impetus may be given to the better training of teachers, the better arrangement and coordination of material and the better form and methods of presentation. Already some important papers have been promised and others will be announced in the near future.

Moreover, no less than six sub-committees, under Klein's International Commission on the Teaching of Mathematics, are now working in this country on topics connected with mathematics of a collegiate grade, and it is supposed that the substance of their reports will be made known in America and will become the basis of discussion at the various meetings of mathematical societies during the Autumn and Winter. From these sources also much should be expected both in pointing out existing conditions and in arousing interest in questions of possible improvements.

ON A FEW POINTS IN THE HISTORY OF ELEMENTARY MATHEMATICS.

By G. A. MILLER, University of Illinois.

The main object of the present note is to call attention to the recent changes of view in reference to several important questions in the history of elementary mathematics. Among the general works on the history of mathematics there is probably none which is more commonly trusted than Cantor's *Vorlesungen über Geschichte der Mathematik.* The first volume of this work is now in its third edition, the second and third volumes are in second editions, while the first edition of the fourth volume appeared as recently as 1908. As the first edition of the first volume appeared in 1880, the rapid succession of new editions of such an extensive work is an index of the rapid recent progress in the development of the history of mathematics. Discoveries have followed each other in such close succession as to call for rapid changes of view even in regard to some of the most fundamental matters.

In support of this statement we shall give a few changes of view as exhibited in the second and third editions of volume I of Cantor's monumental work. On page 576 of the second edition the following words may be found, "According to our opinion the discovery of zero is due to the Hindus." The corresponding statement in the third edition, page 616, reads as follows: "According to our opinion the discovery of zero is due to the Baby-